



## Computational Study: Dynamic Reversal Potentials in a Conductance-based Synaptic Model

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# COMPUTATIONAL STUDY: DYNAMIC REVERSAL POTENTIALS IN A CONDUCTANCE-BASED SYNAPTIC MODEL

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## Introduction

Synapses are points of information transfer between neuronal cells which operate on a micrometre scale. Due to their small size, computational modelling is used to study synaptic behaviour [1]. Traditional synaptic models assume an infinite extracellular space surround synapses and therefore, these models assume constant reversal potentials [2]. However, recent evidence suggests that many synapses are tightly wrapped by astroglial cells [3]. Therefore, we use the assumption that the extracellular space around chemical synapses is finite due to an enwrapped astrocyte to investigate how this will affect reversal potentials in the neuron.

## Aims and Objectives

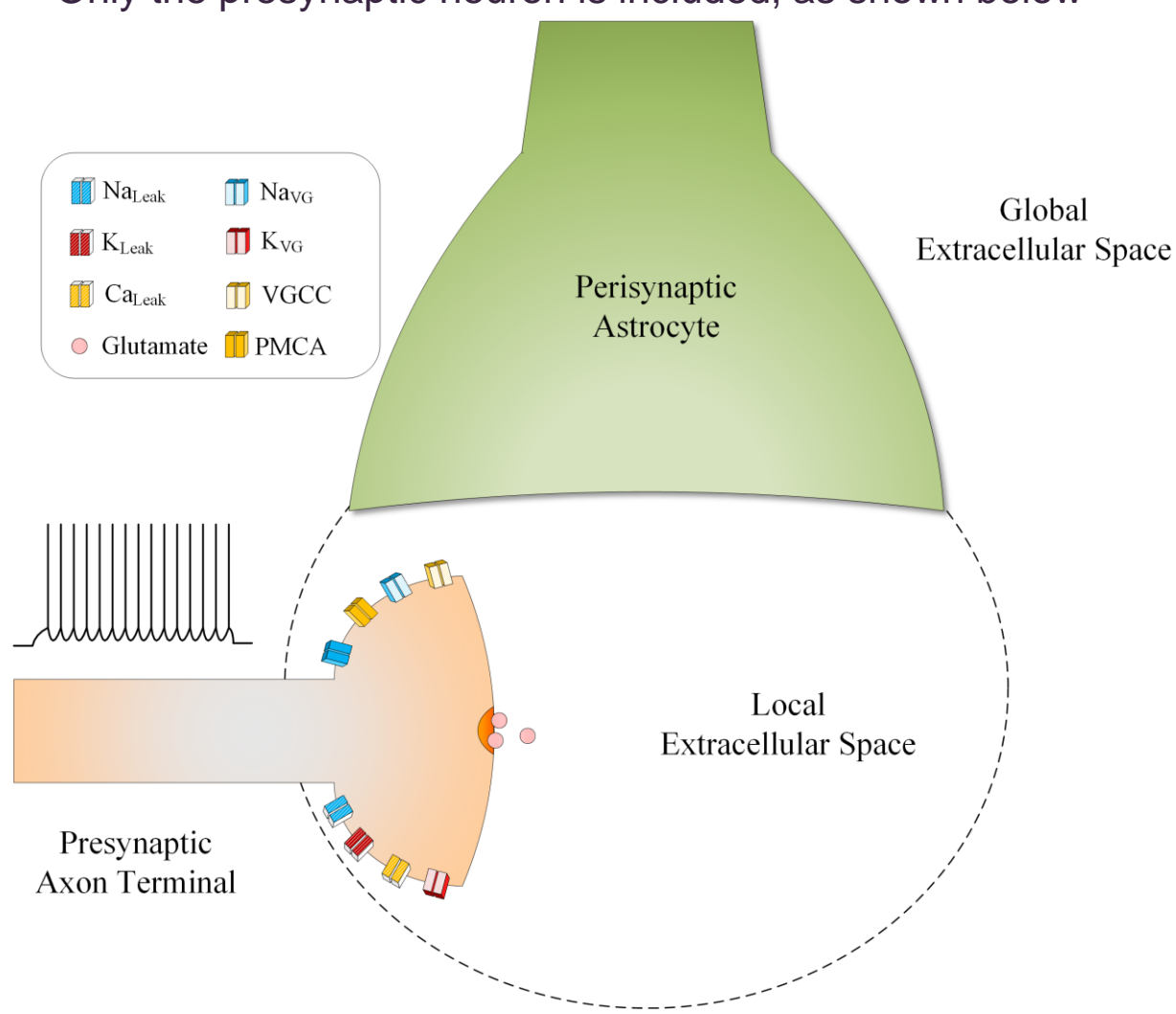
- Our main aim is to investigate whether a perisynaptic astrocyte can impact the behaviour of reversal potentials or the membrane potential in a conductance-based synaptic model
- To achieve this aim, we use the traditional Hodgkin-Huxley formalism to simulate a hippocampal synapse that is surrounded by an astrocyte [2]

## Hypothesis

- We hypothesize that a finite extracellular space will change reversal potentials at the synaptic bouton

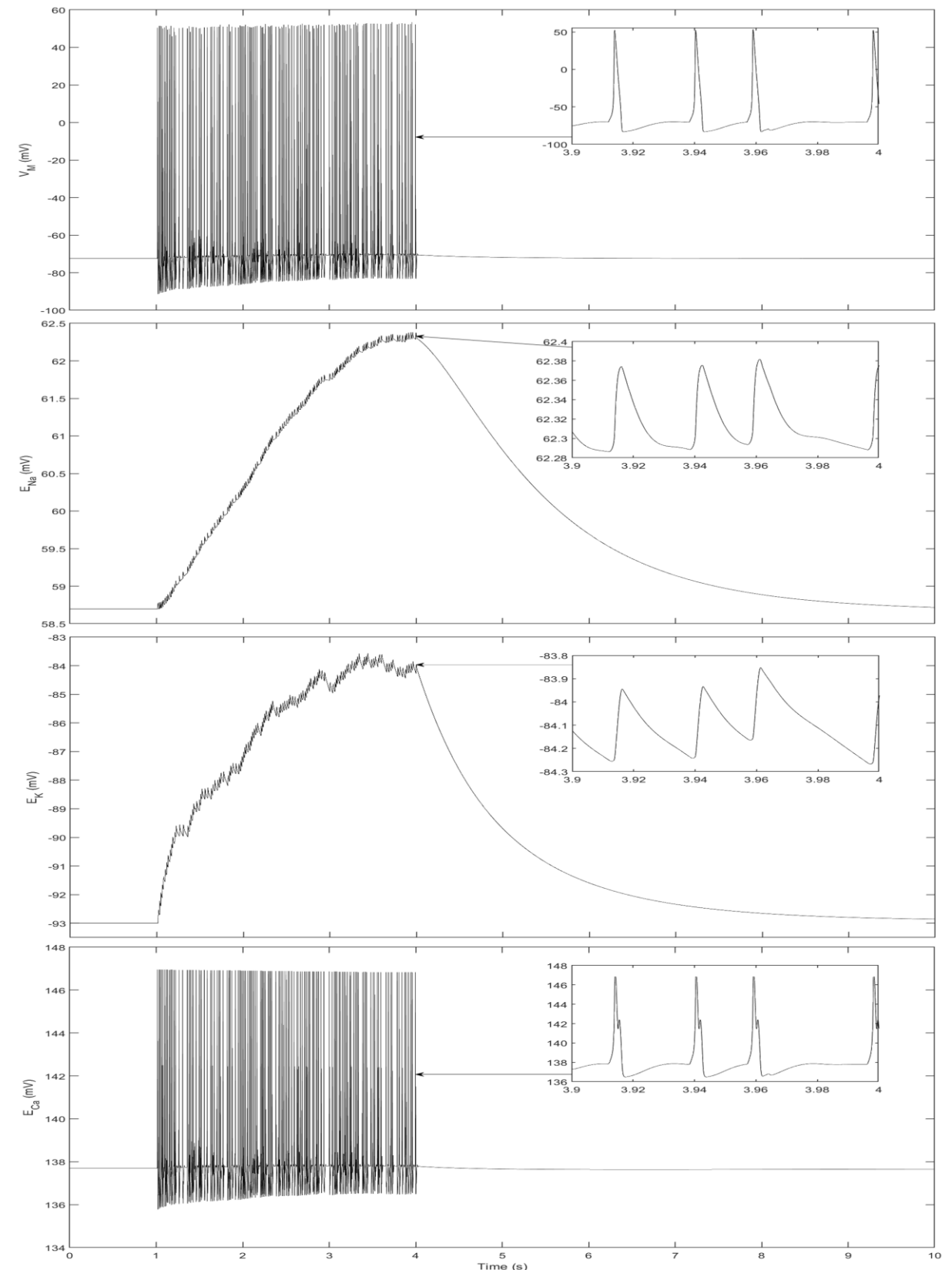
## Methods

- A first-order mathematical framework is used to simulate a conductance-based synaptic model
- A perisynaptic astrocyte is used to create a finite extracellular space (see schematic below)
- Dynamic reversal potentials are used instead of constant reversal potentials
- Only the presynaptic neuron is included, as shown below



## Results

- Simulations ran for 10 seconds using a 10Hz Poisson spike train for 3 seconds of stimulation
- All potentials are in millivolts, inset shows 100ms of detail
- Results show, from top to bottom, membrane potential,  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{Ca}^{2+}$  reversal potentials



## Conclusions

We found that using a finite extracellular space can significantly affect reversal potentials. However, the membrane potential behaviour remains largely unaffected. Therefore, we conclude that using the assumption of constant reversal potentials is a good approximation even at the small scales of a single synapse.

## References

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